



PRELIMINARY GUIDE TO THE IDENTIFICATION OF THE EARLY LIFE
HISTORY STAGES OF BELONID FISHES OF THE WESTERN CENTRAL NORTH
ATLANTIC

BY

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It will be a chapter entitled Belonidae in "Early life history stages of fishes of the western central North Atlantic".

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Needlefishes are a relatively small family of beloniform fishes (Rosen & Parenti 1981) which differ from other members of the order in having both upper and lower jaws extended into long beaks filled with sharp teeth (except in the neotenic South American freshwater genus *Belonion*). The nostrils lie in a pit anterior to eyes. There are no spines in the fins. The dorsal, with 11-43 rays, and anal fins, with 12-39 rays, are posterior in position; the pelvic fins, with 6 soft rays, are located in an abdominal position; and the pectoral fins are short, with 5-15 rays. The lateral line runs down from the pectoral fin origin (except in *Ablennes* and some freshwater genera) and then along the ventral margin of the body. The scales are small, cycloid, and easily detached. Precaudal vertebrae number 33-65, caudal vertebrae 19-41, and total vertebrae 52-97. Some freshwater needlefishes reach only 6 or 7 cm in total length while some marine species may attain 2 m.

The classification of Belonidae is based on Collette et al. (1984), Boughton et al. (1991), and Lovejoy (2000). Ten genera are recognized containing 34 species (Collette 2003b). Eight genera are monotypic or contain only two or three species. Two genera, *Tylosurus* and *Strongylura* contain most of the species in the family, six and 14 respectively. Five species are considered polytypic, containing a total of 17 subspecies. Seven species occur in the western central Atlantic (Collette 2003a), one with two subspecies.

Needlefishes live at the surface and are protectively colored for this mode of life by being green or blue on the back and silvery white on the lower sides and belly. Usually, a dusky or dark blue stripe is present along the sides of the body. The fleshy tip of the lower jaw is frequently red or orange. Most species are marine, but 12 species are restricted to freshwaters, including *Strongylura hubbsi*, found in Atlantic-draining rivers of Mexico and Guatemala, and several species, such as *S. marina*, move long distances into freshwater. Needlefishes are carnivorous, feeding largely on small fishes that they catch sideways in their beaks. Needlefishes tend to leap and skitter at the surface and some people have been injured when accidentally struck by them, particularly at night when the fishes are attracted by lights. Needlefishes are caught by casting or trolling surface or near-surface lures and in floating gill

nets. The flesh is excellent in flavor although some people have misgivings about eating it due to the green color of the bones.

Needlefishes are all oviparous. There is a tendency for the right gonad to be reduced in length or even lost completely in some species, particularly in females. Needlefishes deposit large demersal eggs with well-developed chorionic sticky filaments that attach to vegetation. The eggs are larger, mostly 3-4 mm in diameter than in other beloniforms, 1.0-2.5 mm (Collette et al. 1984). The eggs typically have a homogeneous yolk and a relatively small perivitelline space. The incubation period is relatively long, one to two weeks and the larvae are well-formed and capable of actively feeding at hatching. Correlated with the large egg size, belonids hatch at larger sizes (6.8-14.4 mm) than other beloniforms (3.5-11 mm). Urostyle typically flexed at hatching. Caudal, dorsal, and anal fins generally form first followed by the pectorals and lastly the pelvics. Meristic data for the marine species are given in Table Belonidae 1. Morphology of the jaws and tails change with development as shown in Figures Belonidae 1-6. Most needlefishes go through a "halfbeak" stage where the lower jaw elongates before the upper jaw (Figures Belonidae 2 & 4; Boughton et al. 1991). Measuring head length (tip of lower jaw to end of opercle), snout length (tip of upper jaw to end of opercle), and lower jaw extension (tip of lower jaw to tip of upper jaw) provides the data for describing the duration of the halfbeak stage. Food habits change abruptly (Carr & Adams 1973) from small crustaceans to fishes in *Strongylura* when the upper jaw of juveniles elongates from the halfbeak stage to the full-beaked stage at about 50 mm SL. Duration of the halfbeak stage varies among needlefishes; some species, such as *Tylosurus crocodilus* (see Figure Belonidae 4), lack this stage, others, such as *Platybelone argalus* remain in the halfbeak stage for a long time, and the neotenic South American freshwater genus *Belonion* matures in the halfbeak stage. Juveniles of two genera of needlefishes, *Tylosurus* and *Ablennes*, develop prominent enlarged melanistic lobes in the posterior part of the dorsal fin (Figures Belonidae 5 & 6) and this lobe is retained in adults of *Ablennes*.

Meristic data and available information on eggs, larvae, and juveniles are included for all western central North Atlantic species in the

species accounts as well as the table and figures noted above. Information on early life history of several western North Atlantic species was presented in a series of papers by Charles M. Breder, Jr. and colleagues, information on three species found in the Chesapeake Bay region was summarized by Hardy (1978), eggs and larvae of Belontiiformes were reviewed by Collette et al. (1984), and the halfbeak stage in members of the family was discussed by Boughton et al. (1991). When an adequate developmental series was not

available for western Atlantic material, published figures from other areas (and sometimes other subspecies) are included here to facilitate identification. Some authors have used standard length (SL), others total length (TL) but I use body length (BL) defined as from the posterior edge of the opercle to the base of the caudal rays. I do this because of the allometry of the jaws and because one cannot obtain a base measurement in SL or TL if the jaws are broken.

Table Belonidae 1. Meristics of the fishes of the Family Belonidae from the western central North Atlantic.

Species	Fin Rays							Vertebrae					
	Dorsal		Anal		Pectoral		Pelvic	Precaudal		Caudal		Total	
	Range	Mean	Range	Mean	Range	Mean		Range	Mean	Range	Mean	Range	Mean
<i>Ablennes hians</i>	23-26	24.6	24-27	26.4	12-15	13.8	6	51-63	56.5	30-37	32.2	93-97	94.8
<i>Platybelone argalus argalus</i>	11-15	13.3	17-20	18.2	10-12	10.9	6	44-47	45.0	25-28	26.9	70-74	71.6
<i>Strongylura</i>													
<i>marina</i>	14-17	15.2	16-20	18.0	9-12	11.4	6	41-50	45.1	23-29	26.6	69-77	72.1
<i>notata notata</i>	12-15	13.3	12-15	13.2	9-11	9.8	6	34-38	36.0	19-22	20.9	53-59	56.4
<i>notata forsythia</i>	13-15	13.7	13-15	14.3	9-11	10.1	6	35-40	37.2	20-23	21.5	56-61	58.5
<i>timucu</i>	14-17	15.7	16-20	17.8	10-12	11.0	6	44-48	46.2	24-27	25.7	68-75	71.7
<i>Tylosurus</i>													
<i>acus acus</i>	22-26	23.9	20-24	21.5	13-14	13.2	6	60-64	61.5	28-32	30.8	90-95	91.8
<i>crocodilus crocodilus</i>	21-23	22.3	18-22	20.5	13-15	14.2	6	53-57	54.3	25-29	28.3	80-84	82.3

3

Species	Predorsal	Scales	Gillrakers	Branchiostegals
	Range	Mean		
<i>Ablennes hians</i>	360-430		tubercles	
<i>Platybelone argalus argalus</i>	107-128	116.5	present	
<i>Strongylura</i>				
<i>marina</i>	213-304	256	0	
<i>notata notata</i>	76-117	90	0	
<i>notata forsythia</i>	76-117	90	0	
<i>timucu</i>	120-185	156	0	
<i>Tylosurus</i>				
<i>acus acus</i>	ca. 325-389	347.3	0	14
<i>crocodilus crocodilus</i>	ca. 241-290	260.5	0	

Figure Belonidae 1. Development of posterior part of body from Breder (1932: pl. 3, fig. 5). *Platybelone argalus*: a) 33 mm SL, b) 71 mm SL, and c) 397 mm SL.

Platybelone argalus

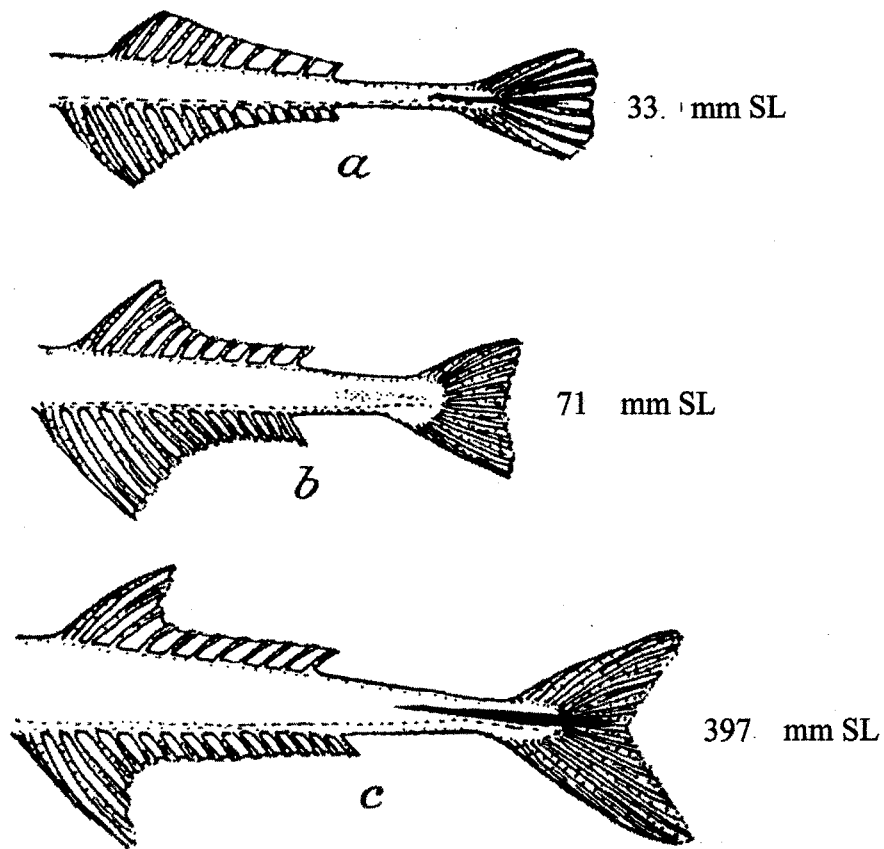


Figure Belonidae 2. Development of beaks from Breder (1932: pl. 1, figs. 1 & 2). Heads in dorsal view: *Strongylura marina* (upper): a) 19 mm SL, b) 170 mm SL, and c) 540 mm SL. *Strongylura notata* (lower): a) 14 mm SL, b) 123 mm SL, and c) 405 mm SL.

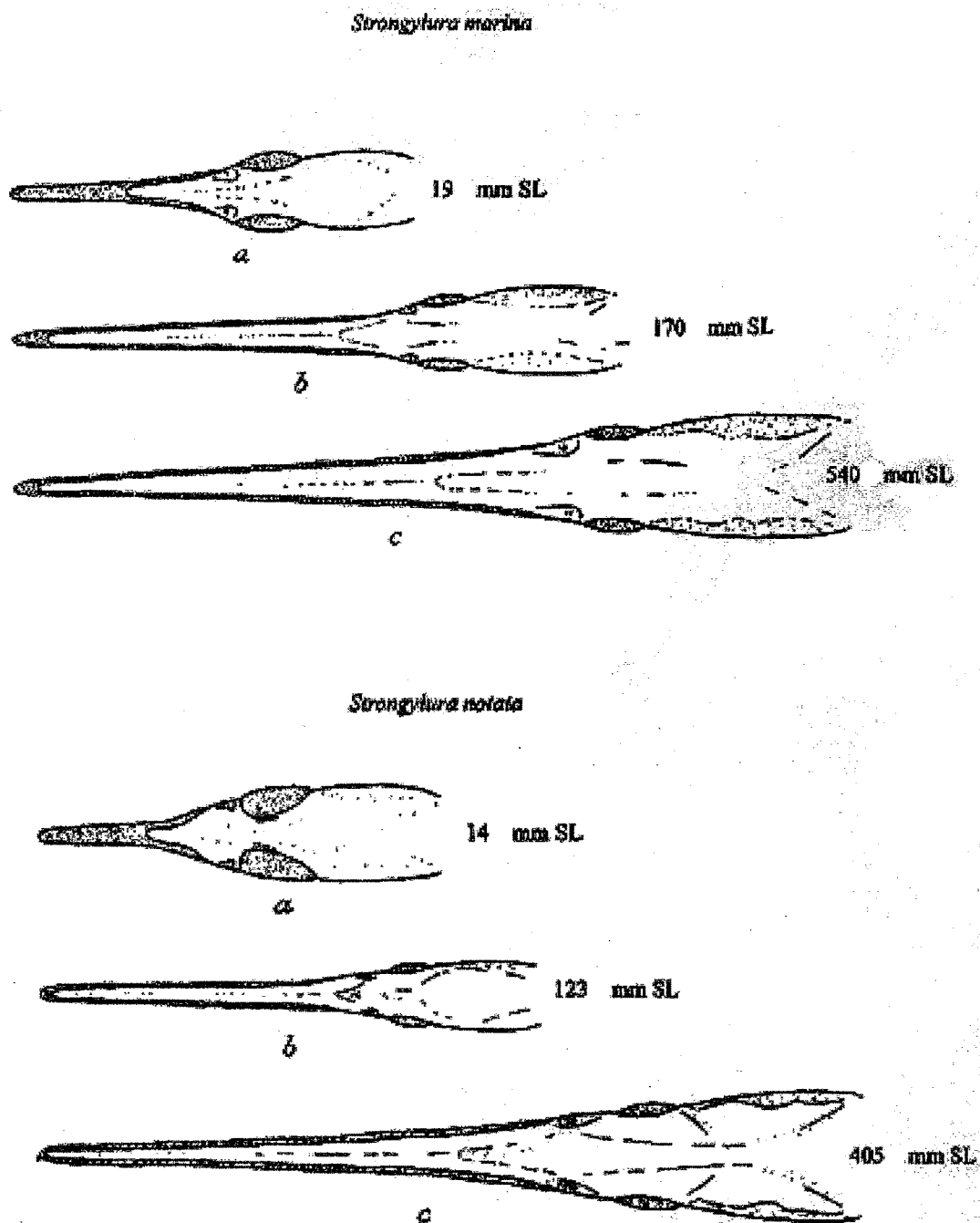


Figure Belonidae 3. Development of posterior part of body from Breder (1932: pl. 3, figs. 1 & 2). *Strongylura marina* (upper): a) 19 mm SL, b) 170 mm SL, and c) 540 mm SL; *Strongylura notata* (lower): a) 14 mm SL, b) 123 mm SL, and c) 405 mm SL.

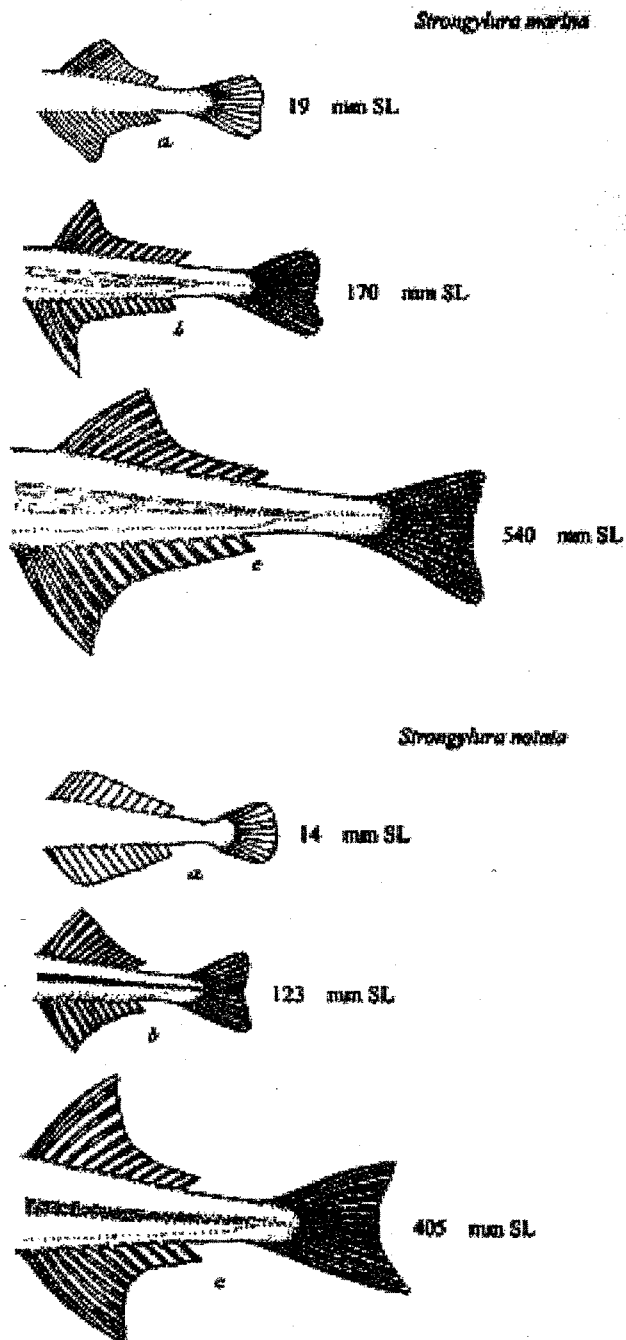


Figure Belonidae 4. Development of beaks from Breder (1932: pl. 2, figs. 2 & 3). Heads in dorsal view: *Tylosurus acus* (upper): a) 23 mm SL, b) 35 mm SL, c) 79 mm SL, and d) 620 mm SL. *Tylosurus crocodilus* (lower): a) 11 mm SL, b) 19.5 mm SL, c) 44.5 mm SL, d) 149 mm SL, e) 231 mm SL, and F) 500 mm SL.

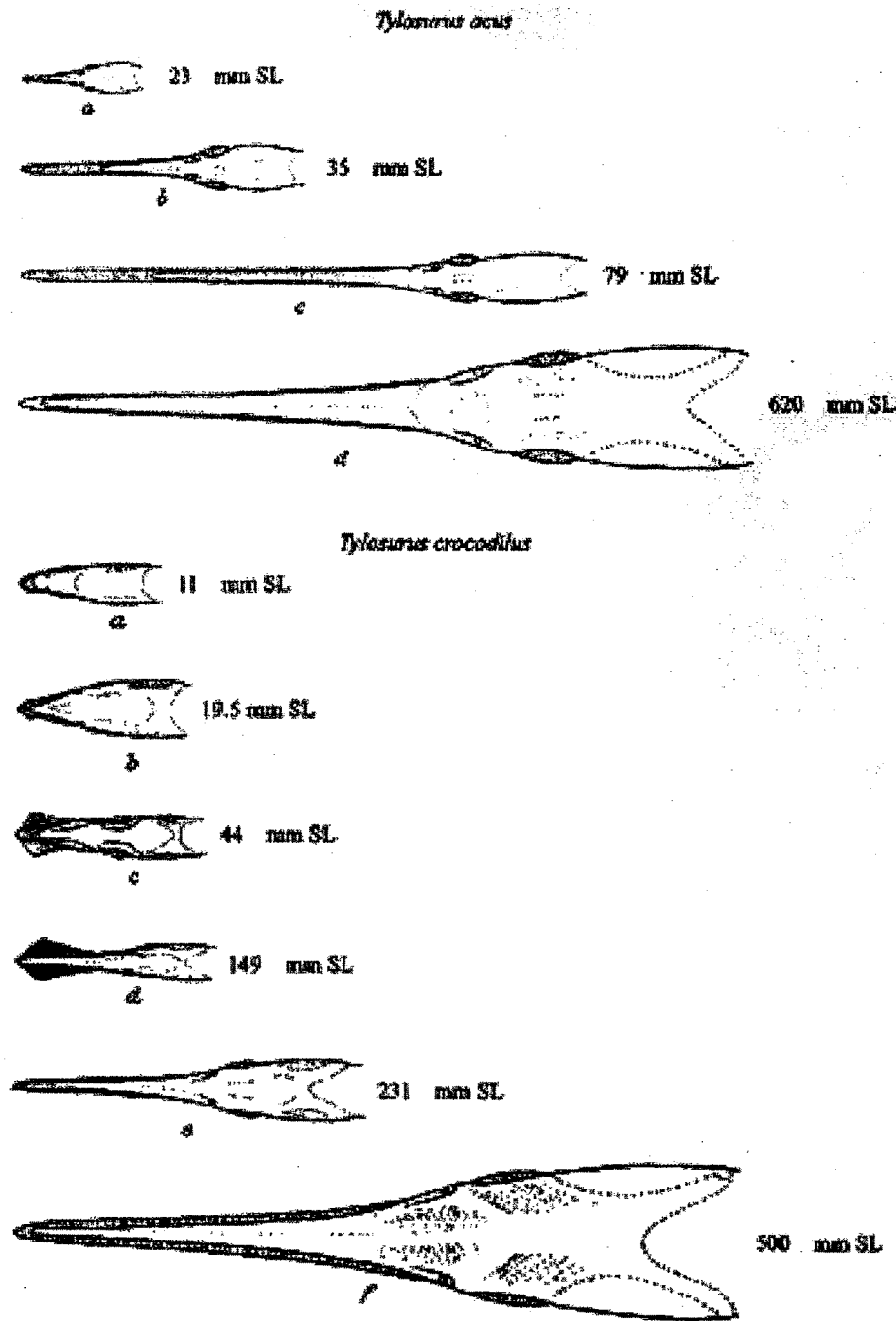


Figure Belonidae 5. Development of posterior part of body from Breder (1932: pls. 4 & 5). *Tylosurus acus* (left): a) 23 mm SL, b) 35 mm SL, c) 79 mm SL and d) 620 mm SL. *Tylosurus crocodilus* (right): a) 11 mm SL, b) 19.5 mm SL, c) 44 mm SL, d) 149 mm SL, e) 231 mm SL, and f) 500 mm SL.

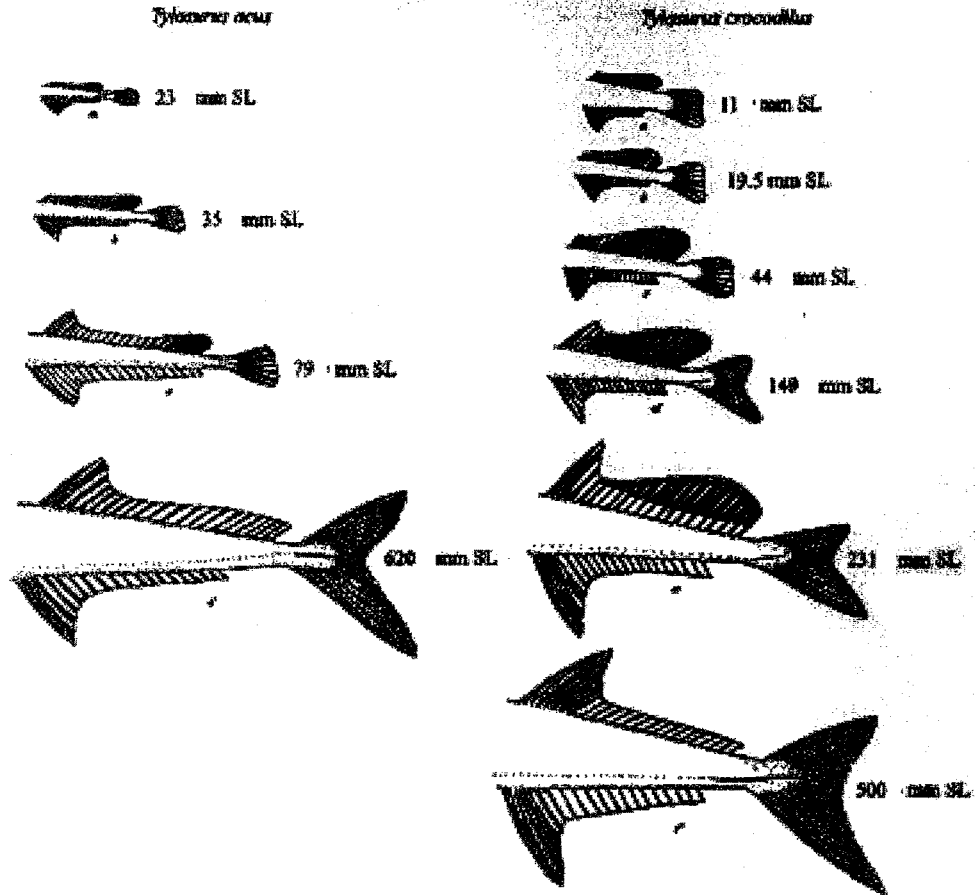
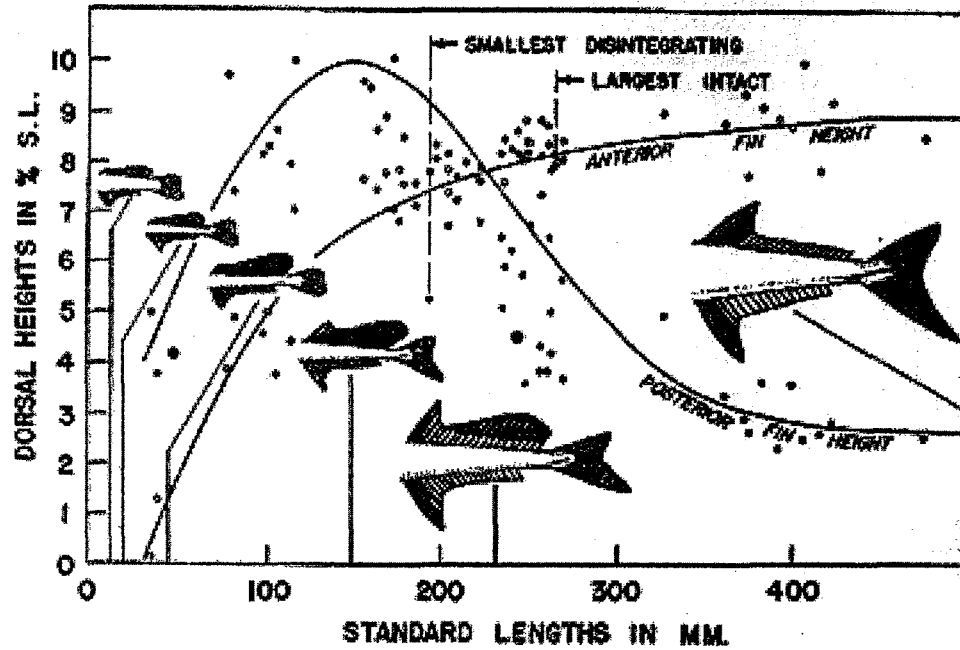


Figure Belonidae 6. Graph depicting changes in anterior and posterior dorsal fin heights in *Tylosurus crocodilus* from Breder & Rasquin (1952: fig. 1).



BELONIDAE*Ablennes hians* (Valenciennes 1846)**MERISTICS**

Vertebrae:	
Precaudal	51-63, mean 56.5
Caudal	30-37, mean 32.2
Total	93-97, mean 94.8
Number of fin rays:	
Dorsal	23-26, mean 24.6
Anal	24-27, mean 26.4
Pectoral	12-15, mean 13.8
Pelvic	6
Gillrakers: minute tubercles present on first gill arch in juveniles; none in adults	
Predorsal scales	360-430

LIFE HISTORY

Range: Worldwide in tropical & subtropical waters.
Habitat: Marine, epipelagic, usually offshore.
ELH Pattern: Oviparous; only right gonad developed; a 278-mm BL female had 660 eggs; eggs attached to vegetation; larvae planktonic.
Spawning: offshore

LITERATURE

Collette et al. 1984; Collette & Parin 1970; Hardy 1978;

EARLY LIFE HISTORY DESCRIPTION**Eggs:**

Diameter: 3.0-3.5 mm
No. of oil globules: 0
Shell: uniformly spaced tufts of filaments, 1-6 per tuft, 37-59 total, filaments longer than diameter of egg

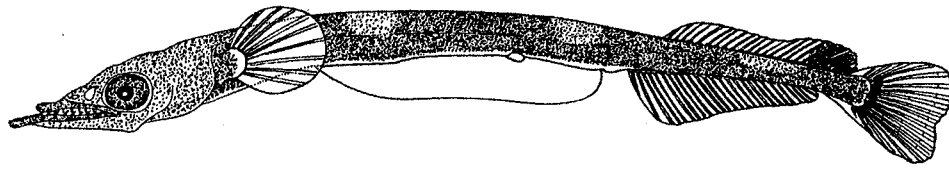
LARVAE: undescribed.

JUVENILES:

Pigmentation: Posterior rays of dorsal fin elongate and forming a melanistic lobe which is maintained in adults.
Diagnostic characters: More anal fin rays (24-28) than any other western Atlantic needlefish.

ILLUSTRATIONS:

A) 12.3 mm BL from Chen 1988: 262, fig. b; B) 22.4 mm SL from Chen 1988; C) 36.1 mm BL juvenile in "halfbeak" stage from Collette et al. 1984: fig. 179D; D) juvenile from Parin 1967: fig. 17a; E) 187 mm BL juvenile.



A



B



C



D



E

BELONIDAE***Platybelone argalus argalus* (LeSueur 1821)****MERISTICS**

Vertebrae:	
Precaudal	44-47, mean 45.0
Caudal	25-28, mean 26.9
Total	70-74, mean 71.6
Number of Fin Rays:	
Dorsal	11-15, mean 13.3
Anal	17-20, mean 18.2
Pectoral	10-12, mean 10.9
Pelvic	6
Predorsal scales	107-128, mean 116.5
Gillrakers	present

LIFE HISTORY

Range: Worldwide with seven subspecies recognized by Collette & Parin 1970; the range of the nominal subspecies is from off the coast of the United States and around Bermuda south throughout the Gulf of Mexico and Caribbean to Fernando de Noronha off the coast of Brazil.

Habitat: Marine, pelagic, particularly abundant around islands such as in the West Indies.

ELH Pattern: Oviparous; right ovary longer than left; a 266-mm BL female had 944 eggs in the left ovary, 1,136 eggs in the right.

Spawning: ripe females occur at Puerto Rico in May-June

LITERATURE

Breder 1932; Collette et al. 1984; Collette and Parin 1970; Erdman 1976

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Shell: eggs with filaments that attach to vegetation.

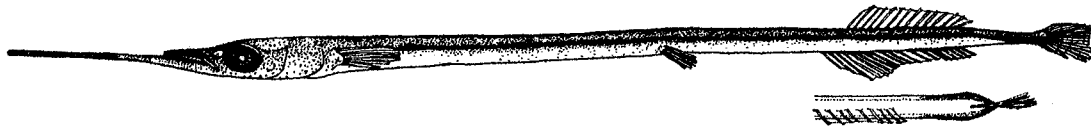
LARVAE: undescribed.

JUVENILES:

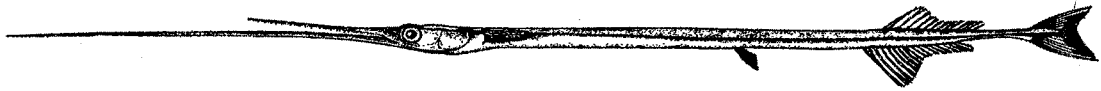
Diagnostic characters: Juveniles remain in the halfbeak stage for longer than other species of needlefishes in the western Atlantic, to at least 100 mm BL.

ILLUSTRATIONS

A) 53.4 mm SL *Platybelone argalus platyura* with ventral tail view inset from Chen 1988: 260, fig. b; B) juvenile in "halfbeak" stage, 96 mm BL, from Collette et al. 1984: fig. 179E.



A



B

BELONIDAE***Strongylura marina* (Walbaum 1792)****MERISTICS**

Vertebrae:	
Precaudal	41-50, mean 45.1
Caudal	23-29, mean 26.6
Total	69-77, mean 72.1
Number of Fin Rays:	
Dorsal	14-17, mean 15.2
Anal	16-20, mean 18.0
Pectoral	9-12, mean 11.4
Pelvic	6
Predorsal scales	213-304, mean 256
Gillrakers	0

LIFE HISTORY

Range: Western Atlantic from Massachusetts south to Rio de Janeiro but absent from the Bahamas & West Indies.

Habitat: Epipelagic, marine and estuarine but frequently extending long distances up rivers. Land-locked populations exist in Florida freshwaters.

ELH Pattern: Oviparous; only one gonad, a 294-mm BL female had about 1,000 eggs.

Spawning: Inshore in bays and estuaries; in fresh and brackish waters of the Potomac amidst submerged algal masses from May 20-June 10; ripe females have been found in early May in the Chickahominy River, VA, from March to August in Lake Seminole, FL, and in July in Laguna Madre, TX.

LITERATURE

Breder 1932; Collette 1974; Collette et al. 1984; Foster 1974; Hardy 1978; Massman 1954; Ryder 1882; Simmons 1950; Yerger 1977

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 3.5-3.6 mm.

No. of oil globules: 0

Yolk: At hatching, yolk mass large, oval; head not flexed over yolk; mouth open.

Shell: numerous filaments about equal in length to the diameter of the egg distributed all over the egg.

Incubation: finfold developing at 165 hours but incubation period not known.

LARVAE:

Length at hatching: 9.2-14.4 mm.

Length at flexion: urostyle flexed at hatching.

Length at transformation:

Sequence of fin development: D& A rays formed at hatching; rays form in P₁ fins by 25.3 mm

TL; rays form in P₂ fins by 30.0 mm TL

Jaws: Upper & lower jaws equal in length at 25.3 mm TL, lower jaw much longer than upper at 48.2 mm TL.

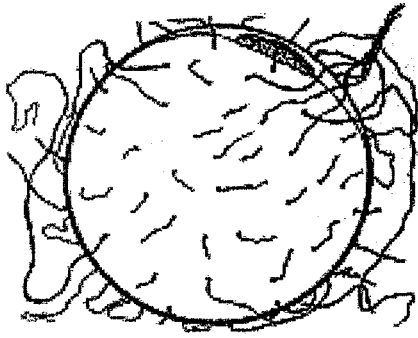
Pigmentation: at 25.3 mm, melanophores scattered over head & body, large melanophores concentrated on lower sides anterior to anus, and a distinct row of melanophores on each side of mid-dorsal line.

JUVENILES:

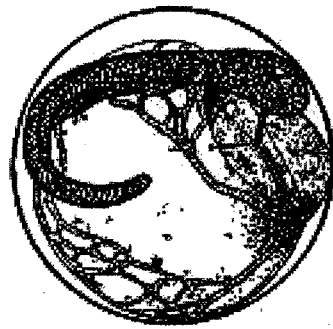
Pigmentation: At 45 mm, dark above, light below; a definite dark mid-lateral band of pigment from eye to base of caudal fin.

ILLUSTRATIONS:

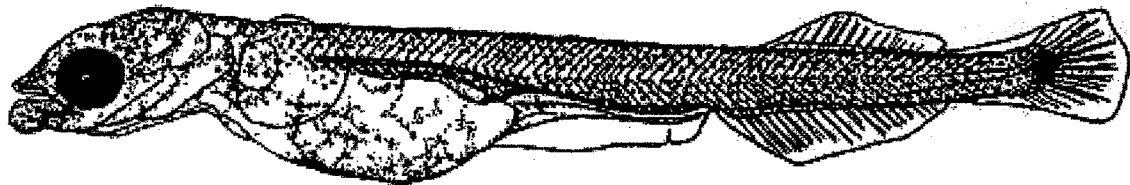
A) Egg with attachment filaments, 3 hours after fertilization from Ryder 1882: pl.; B) Embryo, 165 1/2 hours from Ryder 1882: pl. C) yolk-sac larva, 12.0 mm TL; D) Yolk-sac larva, newly hatched, 14.4 mm TL from Hardy 1978: fig. 41B; E) juvenile in "halfbeak" stage, 23.5 mm BL from Collette et al. 1984: fig. 179C.



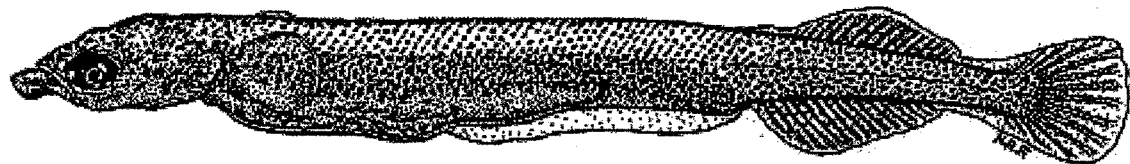
A



B



C



D



E

BELONIDAE***Strongylura notata* (Poey 1860)****MERISTICS**

Vertebrae:	
Precaudal	34-38 in <i>S. n. notata</i> 35-40 in <i>S. n. forsythia</i>
Caudal	19-22 in <i>S. n. notata</i> 20-23 in <i>S. n. forsythia</i>
Total	53-59 in <i>S. n. notata</i> 56-61 in <i>S. n. forsythia</i>
Number of Fin Rays:	
Dorsal	12-15 in <i>S. n. notata</i> 13-15 in <i>S. n. forsythia</i>
Anal	12-15 in <i>S. n. notata</i> 13-15 in <i>S. n. forsythia</i>
Pectoral	9-11, usually 10
Pelvic	6
Predorsal scales	76-117, mean 90
Gillrakers	0

LIFE HISTORY

Range: Western Atlantic, two subspecies: *S. n. notata* occurs in Cuba, Jamaica, and along the coast of Central America from Mexico to Honduras; *S. n. forsythia* Breder 1932 occurs in the Bahamas, southern Florida, & the Gulf of Mexico west to Mobile Bay.

Habitat: Marine, epipelagic, coastal.

ELH Pattern: Oviparous; right ovary slightly longer than left, ratio of left to right 0.8-1.4; a 248-mm BL female had 428 eggs in the left ovary, 470 in the right.

Spawning: February-July in the Indian River Lagoon, Florida.

LITERATURE

Breder 1932; Breder 1959; Collette 1974; Gilmore 1978.

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 3.2-3.3 mm.

No. of oil globules: 0

Shell: uniformly distributed adhesive filaments present

Incubation: about two weeks

Pigmentation: only xanthophores

LARVAE

Length at hatching:

Length at flexion:

Length at transformation:

Sequence of fin development:

Pigmentation:

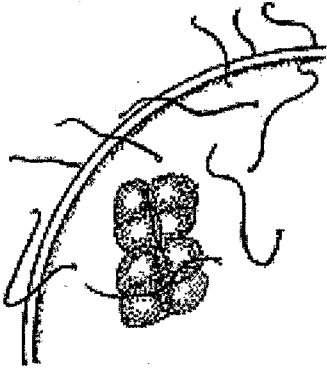
JUVENILES:

Pigmentation:

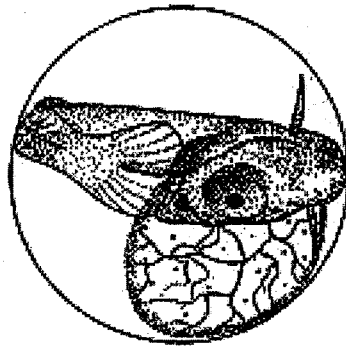
Diagnostic characters: *S. notata* has fewer A rays (not more than 15) than the other two species of *Strongylura* (16 or more) and fewer vertebrae (53-61) than any other needlefishes in the area (68-97). It is the only western Atlantic species of *Strongylura* to have the end of the maxilla concealed under the preorbital bone.

ILLUSTRATIONS

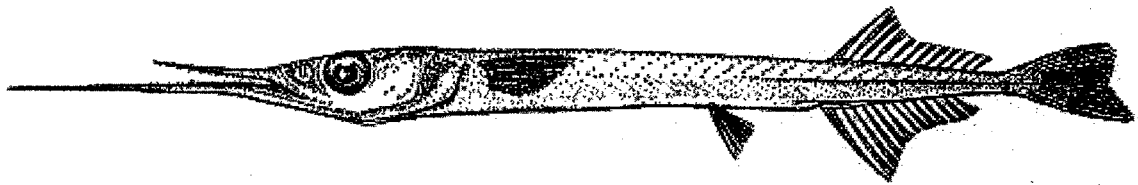
A) Part of egg at eight-cell stage, 2 hrs, 20 min after fertilization, showing external adhesive threads from Breder 1959; B) Advanced embryo with much reduced yolk, 213 hrs, 15 min after fertilization from Breder 1959; C) juvenile 16.2 mm BL, in "halfbeak" stage; original, TU18200.



A



B



C

BELONIDAE***Strongylura timucu* (Walbaum 1792)****MERISTICS**

Vertebrae:	
Precaudal	44-48, mean 46.2
Caudal	24-27, mean 25.7
Total	68-75, mean 71.7
Number of Fin Rays:	
Dorsal	14-17, mean 15.7
Anal	16-20, mean 17.8
Pectoral	10-12, mean 11.0
Pelvic	6
Predorsal scales	120-185, mean 156
Gillrakers	0
Branchiostegals	

LIFE HISTORY

Range: Western Atlantic, southern Florida, Bahamas, West Indies, & Central America south to Rio de Janeiro, Brazil.

Habitat: Marine, epipelagic.

ELH Pattern: Oviparous; two gonads, right ovary longer than left, ratio of left to right 1.0-1.7; a 250-mm BL female had 405 eggs in the left ovary, 970 in the right.

Spawning: ripe females occur in June in the northern Caribbean

LITERATURE

Collette 1974; Erdman 1976

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Yolk: eggs with filaments attaching to vegetation.

LARVAE: unknown**JUVENILES:****Pigmentation:**

Diagnostic characters: a 35.5 mm BL specimen is in the halfbeak stage, head length 19.1 mm, snout length 12.8 mm, and lower jaw extension 6.4 mm.

ILLUSTRATIONS:

A) 35.5 mm BL 'halfbeak stage', USNM 144554, Puerto Rico, original

BELONIDAE

Strongylura timucu (Walbaum 1792)



BELONIDAE***Tylosurus acus acus* (Lacepède 1803)****MERISTICS**

Vertebrae:	
Precaudal	60-64, mean 61.5
Caudal	28-32, mean 30.8
Total	90-95, mean 91.8
Number of Fin Rays:	
Dorsal	22-26, mean 23.9
Anal	20-24, mean 21.5
Pectoral	13-14, mean 13.2
Pelvic	6
Predorsal scales	ca. 325-389, mean 347.3
Gillrakers	0
Branchiostegals	14

LIFE HISTORY

Range: Worldwide in tropical & subtropical seas within the 23.9°C isotherm, except replaced in the eastern Pacific by *Tylosurus pacificus*. The nominal subspecies is found in the western Atlantic from Massachusetts & Bermuda south to Rio de Janeiro, Brazil.
 Habitat: Marine, epipelagic, usually offshore.
 ELH Pattern: Oviparous, eggs with filaments
 Spawning:

LITERATURE

Breder 1932; Breder & Rasquin 1954; Collette et al. 1984; Collette & Parin 1970; Hardy 1978b; Mito 1958; Parin 1967

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 3.22-4.0 mm.
 Shell: uniformly spaced tufts of 2-3 filaments longer than egg diameter.
 Incubation: About 10-12 days at 25.0-30.4°C.
 Pigmentation: At 55-61 hours, yellow pigment on body, black pigment on yolk; at 110 hours, black pigment on body, network of pigment on yolk; at 182 hours, heavy pigment developed over eye, body, & yolk sac.

LARVAE:

Length at hatching: 10.16 mm.
 Length at flexion: flexed at hatching.
 Sequence of fin development: D & A fins develop in the egg at 168 hours, P₁ by hatching, and P₂ after 14 mm TL.
 Pigmentation: At 10.16 mm TL, the newly hatched larva has body & yolk sac completely covered with chromatophores; chromatophores less numerous, more stellate on head and jaws; pigment developed in dorsal and anal fins and near base of caudal.

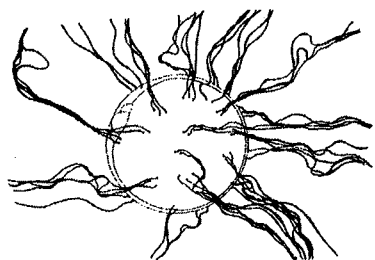
JUVENILES:

Pigmentation: Young up to ca. 30 mm sometimes light green with four broad bars of bright silver, the first through the eye, the second just in advance of the pelvics, the third at the dorsal fin origin, and the fourth at the caudal peduncle. Dorsal fin with greatly produced melanistic posterior lobe first evident at 23 mm SL, at maximum development from 169-244 mm, & still evident up to 605 mm.

Diagnostic characters: Juveniles of *Ablennes* & *Tylosurus* have a greatly produced melanistic posterior lobe in the dorsal fin. *Tylosurus* have fewer anal fin rays (18-24) than *Ablennes* (24-28). *Tylosurus acus* has more vertebrae (90-95) than *T. crocodilus* (80-84).

ILLUSTRATIONS

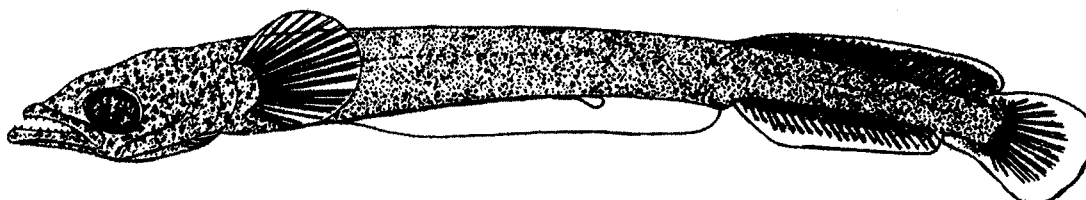
Fig. 1. A) egg, 4-cell stage, 2 1/2 hours after fertilization, from Mito 1958; B) newly-hatched larva, 10.16 mm TL, from Mito 1958: pl. 23, fig. 5; C) larva, 14.1 mm TL, from Mito 1958: pl. 23, fig. 6; D) 30.0 mm SL *Tylosurus acus melanotus* from Chen 1988: 264, fig. d; E) juvenile, 48.0 mm TL, from Parin 1967; F) juvenile, 130 mm BL, from Collette et al. 1984: fig. 179G.



A



B



C



D



E



F

BELONIDAE***Tylosurus crocodilus crocodilus* (Peron & LeSueur 1821)****MERISTICS**

Vertebrae:	
Precaudal	53-57, mean 54.5
Caudal	25-29, mean 28.3
Total	80-84, mean 82.3
Number of Fin Rays:	
Dorsal	21-23, mean 22.3
Anal	18-22, mean 20.5
Pectoral	13-15, mean 14.2
Pelvic	6
Predorsal scales	ca. 241-290, mean 260.5
Gillrakers	0

LIFE HISTORY

Range: Worldwide in tropical & subtropical waters, the nominal subspecies in the Atlantic & Indo-West Pacific, *T. c. fodiator* Jordan & Gilbert in the eastern Pacific. In the western Atlantic, from New York & Bermuda south to Bahia, Brazil.

Habitat: Marine, epipelagic.

ELH Pattern: Oviparous, eggs with filaments attaching to vegetation.

Spawning:

 Season: May & June in Haiti.

LITERATURE

Breder 1932; Collette et al. 1984; Collette & Parin 1970; Masurekar 1967

EARLY LIFE HISTORY DESCRIPTION**EGGS:**

Diameter: 4.0-4.1 mm.

No. of oil globules: Minute scattered oil globules or none.

Yolk: transparent.

Shell: numerous long fine, transparent, thread-like filaments.

Incubation: 8-10 days.

Pigmentation: At estimated 144-168 hours, body covered with yellowish brown & black melanophores; eye black. At estimated 184-192 hours, head free of pigment; body covered with small stellate melanophores which spread on to dorsal third of yolk; numerous brownish or reddish brown spots between black melanophores.

LARVAE:

Length at hatching: 10.7-12.0 mm.

Length at flexion: flexed at hatching.

Sequence of fin development: yolk-sac larva at hatching, 10.9 mm SL, incipient rays formed in D, A, C & P₁ fins.

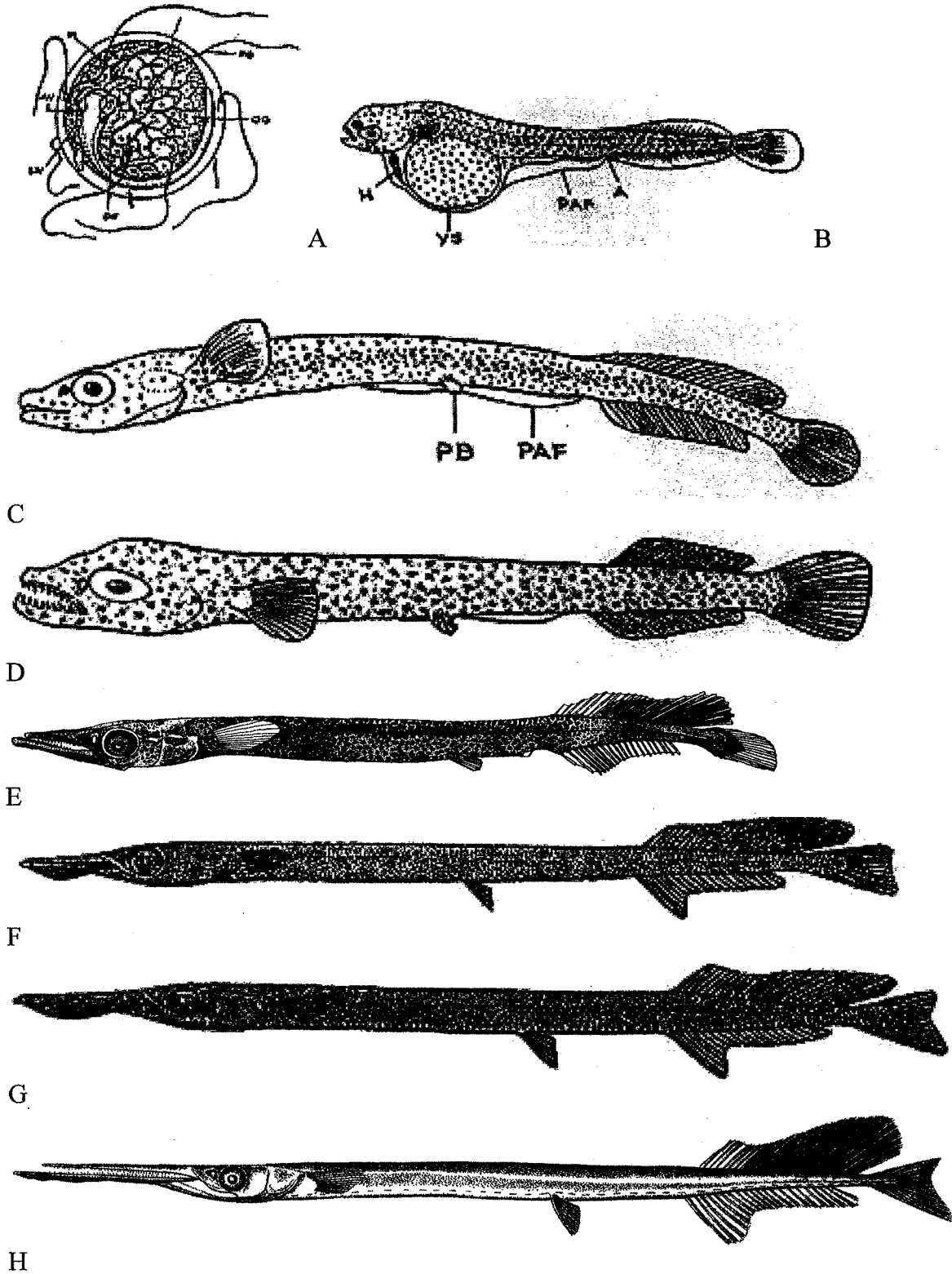
JUVENILES:

Pigmentation: At 21 mm, faint brownish stellate chromatophores on upper body, ventral and ventrolateral surfaces dark. At 25-30 mm, posterior rays of dorsal fin blackish, other fins whitish.

Diagnostic characters: Juveniles lack the halfbeak stage found in most other needlefishes. Teeth in both upper & lower jaws of juveniles are directed distinctly anteriorly unlike the vertical teeth found in all other needlefishes.

ILLUSTRATIONS

A) egg ca. 66-90 hours old from Masurekar 1967: fig. 2; B) newly hatched yolk-sac larva, 10.9 mm TL from Masurekar 1967: fig. 3; C) larva, 15.2 mm TL from Masurekar 1967: fig. 4; D) juvenile, 21.0 mm TL from Masurekar 1967: fig. 7; E) 37.9 mm SL from Chen 1988:262, fig. d.; F) juvenile, 55 mm TL from Parin 1967: fig. 22; G) juvenile, 120 mm TL from Parin 1967: fig. 22; H) juvenile, 96.3 mm BL from Collette et al. 1984: fig. 179J.



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